7318 APRIL 1945

RECEIVED
MAY 9 - 1945
O. S. U. LIBRARY

UNITED STATES
DEPARTMENT OF THE INTERIOR
HAROLD L. ICKES, SECRETARY

BUREAU OF MINES
R. R. SAYERS, DIRECTOR

INFORMATION CIRCULAR

ELECTRONIC MINE-SHAFT SIGNAL SYSTEM AT MAGMA COPPER CO., SUPERIOR, ARIZ.

BY

H. C. LOESCHE

Generated on 2024-09-19 14:44 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

. 7318,
il 1945.

INFORMATION CIRCULAR

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

ELECTRONIC MINE SHAFT SIGNAL SYSTEM AT MAGMA COPPER CO. SUPERIOR, ARIZ.[1]

By H. C. Loesche[2]

INTRODUCTION

The problem of signaling to the hoisting engineer from the cage in a ft mine has been given considerable thought and attention by engineers mine operators seeking to increase the safety and efficiency of hoisting.

HISTORY

R. L. Rutherford,[3] an employee of the Magma Copper Co., Superior Ariz., lizing the need for a simple and practical moving-cage signaling system, n a series of experiments early in 1937. Available electrical moving- e signals in operation at this date required that signal wires be installed the shaft. To make a simple, positive signal without wires, the first ex- iments used the pipe lines in the shaft for carrying the signal current, these experiments were not successful.

The idea of using the hoisting cable to carry the signal current seemed irable, as it would eliminate the necessity for signal wires in the shaft, urce of trouble in themselves and an added cost for material and instal- ion. The electronic system incorporates the cable as a conductor.

Certain features of the electronic signaling device are patented by herford.

CONSIDERATIONS OF DESIGN

The design of this apparatus was governed by the following considerations; Equipment had to be rugged enough to withstand the rough treatment received ing operation; (2) simplicity of design had to be kept in mind because airs had to be made with the least possible delay by mine electricians, who not generally radio technicians; (3) the cage installation had to be com- t on account of the limited space available on a skip or cage; and (4) the ctrical characteristics of the system had to be in harmony with physical

---

The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7318."

Associate mining engineer, Bureau of Mines, Phoenix, Ariz.

Inventor of the electronic signal.

Generated on 2024-09-19 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

characteristics found in mine shafts, for a practical signal system should work with the conditions found in mine shafts and not in opposition to them.

All of the above considerations have been met in the design of the electronic shaft signal system.

EQUIPMENT

The system consists of a transmitter on the cage and a receiver on the surface (fig. 4). The hoisting cable and the earth are the carrier mediums. The apparatus is installed as shown in figure 3. The transmitter is a single tube tone modulated oscillator feeding into a low-voltage winding, designed to match the approximate impedance of the cable ground system. At low frequency or with direct current, the voltage difference across a 10- to 20-foot length of hoisting cable would be very low, whereas at high frequencies the same length of cable offers considerable impedance, often with a potential difference of 20 or 30 volts between the two grounds. The practical effect is similar to cutting the cable and applying a series potential of the same voltage and thereby developing a circuit to the surface, the cable being one conductor and the earth the other. The voltage involved by this method is low; therefore the insulation of the ground wires does not present a problem. There are no coils or attachments around or attached to the cable to get in the way when resocketing, cutting, or any repairs to the cable or hoisting equipment. The only connections are two grounds, one being a clamp on the hoisting cable and the other a ground connection to the cage proper (see fig. 1). The path to earth from the cage or skip is by capacity effects. If the shaft is wet, the earth is of course by direct contact. Therefore, the signal current is actually helped by adverse conditions (see figs. 1 and 3).

The surface or receiving equipment consists of a signal pick-up loop mounted below the sheaves with one leg of the loop paralleling the cable. A clearance of several inches is allowed to prevent the cable from coming in contact with the loop and dislodging it. This manner of mounting allows the signal to be picked up from the cable by means of a transformer effect, the cable being a quarter-turn primary coupled to the multiturn loop. This method eliminates the possibility of the apparatus interfering with any work being done on the cable or sheave. The output of this pick-up loop is fed to a fixed frequency receiver, and the output of the receiver is connected to the indicator lamp and speaker at the hoist (see figs. 2 and 3). On permanent installations there is a small speaker at the receiver for the purpose of tuning the receiver (see fig. 2).

OPERATION OF TWO SEPARATE SYSTEMS IN SAME SHAFT

Two systems in different compartments of the same shaft may be operated without interference. Three or four different systems could be operated, but this practice is not recommended. Separation of different systems is done by using a different carrier frequency just as the different broadcast stations are separated in radio transmission.

Generated on 2024-09-19 15:34 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

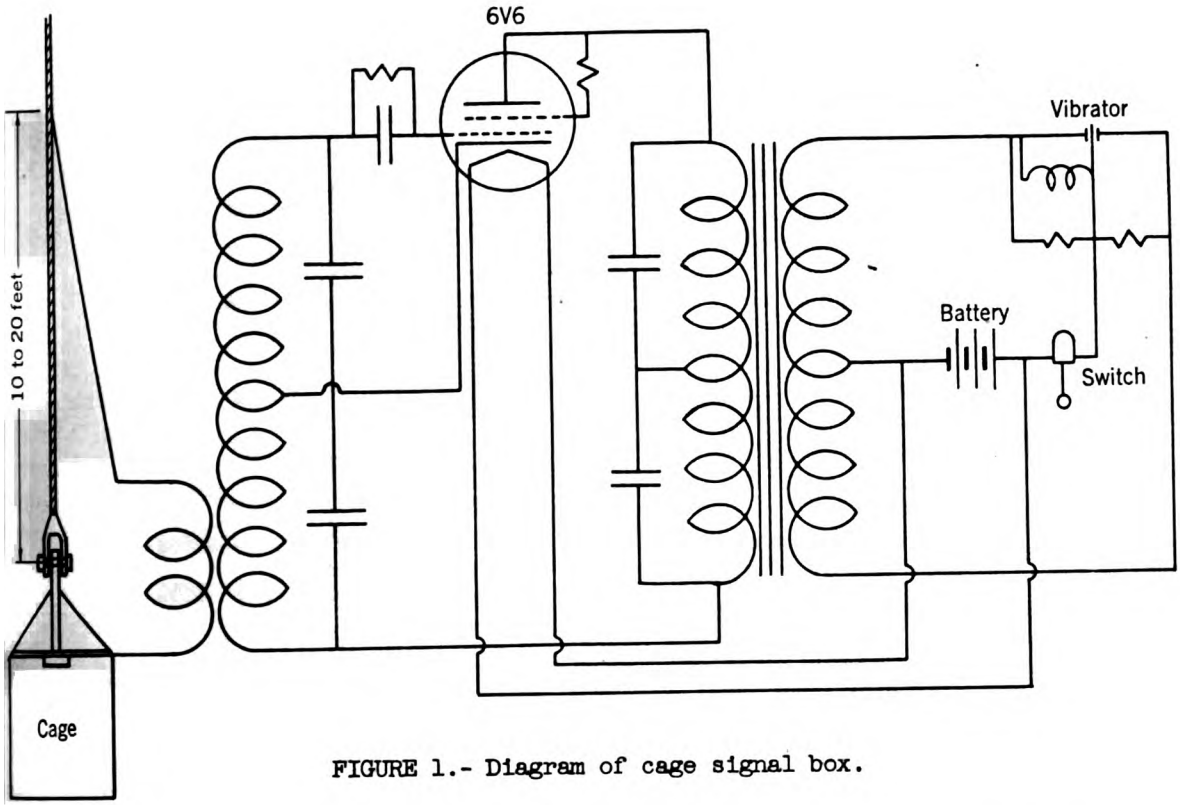

FIGURE 1.- Diagram of cage signal box.

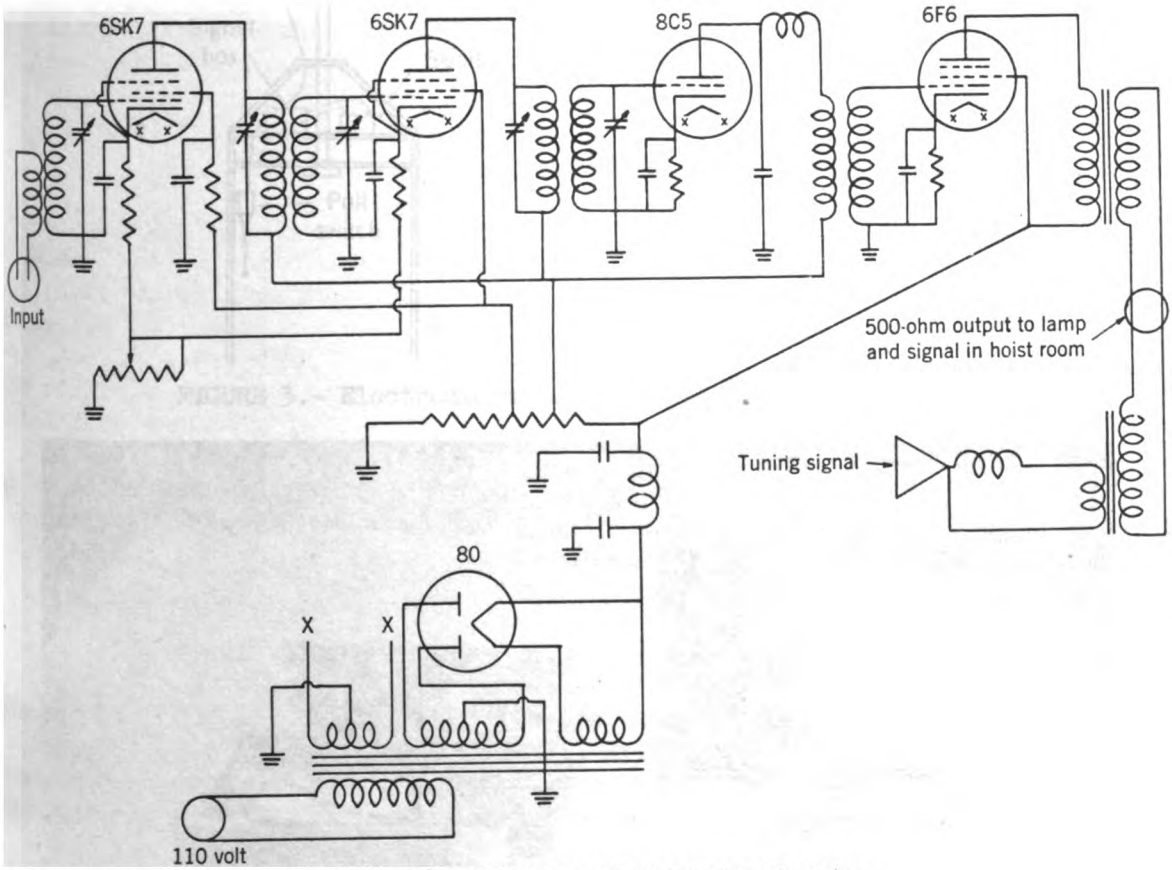

FIGURE 2.- Diagram of receiver circuit.

Generated on 2024-09-19 14:46 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

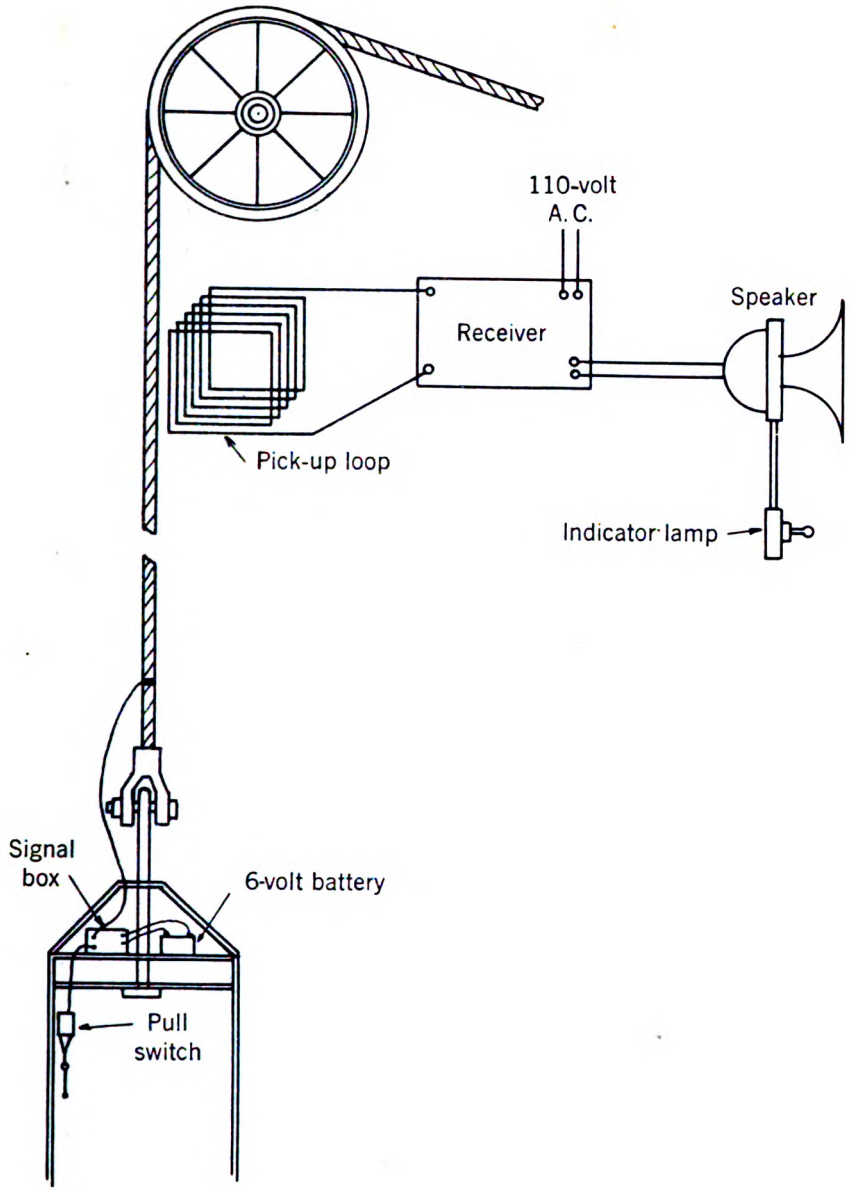

FIGURE 3.- Electronic mine-shaft signal-system hook-up.

FIGURE 4.- Cage transmitter and surface receiver.

Generated on 2024-09-19 15:21 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from
THE OHIO STATE UNIVERSITY

The standard of a 10-kilocycle separation as used in radio transmission not sufficient for shaft signaling. A wide separation of at least 100 locycles must be used, and it is equally important that the frequencies lected have a proper harmonic relation to prevent cross signaling. A wide paration, as stated above, gives adequate insurance against cross signaling tween the different compartment signals.

TYPES

The electronic hoist signal is made in two models - one for permanent stallation and the other, a portable model, for emergency operations or en a signal is needed for repairmen working in a shaft. The portable model n be set up and taken down in a few minutes, as there are few connections be made. The advantage of using a portable model in shaft repair work is at nothing is left in the shaft that might deteriorate when not in use.

Several successful signaling devices can be operated from a moving cage, t the simplicity of the electronic system and the use of the cable to carry e signal do away with a signal wire down the shaft, which makes this paratus a more practical and simple installation.

ADJUSTMENTS OF SYSTEM

No adjustments are made on the cage or sending part of the apparatus. e early equipment had certain frequency adjustments, but these have since en eliminated.

All adjustments are made on the receiver which is located on the surface l consist of tuning the receiver to match the transmitter frequency. ntrol is provided to regulate the sensitivity of the receiver and control e strength of the signal. When these adjustments are set, it is not cessary to change them for long periods.

POWER

Permanent cage transmitters are powered with a standard 6-volt storage ttery. The battery requires charging about twice a week on the older-type paratus and once a week on the newer type. The average life of a battery this service is about 1 year. The portable apparatus uses a lighter 6- lt lead-plate-type battery. The receiver is powered from 110-volt 60- or cycle current, whichever is used for mine operations.

SAFETY FEATURES

The electronic system does not use relays in any part of its operation. e signal tone originates at the transmitter on the cage by means of a brator and is reproduced at the receiver. Noise is not picked up by the ceiver, for it is operated at a low sensitivity. Some static is present ring electrical storms but would not be taken for a signal, as there is much difference between static and the signal as there is between music

Generated on 2024-09-19 15:24 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY

and static on a home radio set. This would not be true if a relay were used to ring a bell or operate a buzzer. A 2-watt neon indicator lamp is operated by means of a step-up transformer from the signal current and serves the dual purpose of indicating which signal is being operated and of indicating the signal strength by the brightness with which it burns.

CONCLUSION

In some States, the law requires two separate systems of signaling the hoisting engineer. A system by which the hoisting engineer can be signaled from the cage, whether it is at rest or in motion, should always be one of these systems. The system described is fully as economical as one operated from the levels, when its many advantages are taken into consideration and its original cost is spread over a number of years.

Ability to signal from a moving cage has many definite safety features and economic advantages. It is important that a suitable signaling device be installed in all shafts in which men's lives may depend upon their ability to signal the hoisting engineer from a moving cage, for in many instances men have lost their lives through their inability to signal from the cage, as in mine fires, or by being lowered into the sump, or by other unforeseen accidents. The cost of a single accident can more than offset the cost of a moving-cage signaling device.

Generated on 2024-09-19 14:48 GMT / https://hdl.handle.net/2027/osu.32435030643886
Public Domain, Google-digitized / http://www.hathitrust.org/access_use#pd-google
Digitized by Google
Original from THE OHIO STATE UNIVERSITY